Fish & Wildlife Division

SPECIES AT RISK

Status of the Western Small-footed Bat (*Myotis ciliolabrum*) in Alberta

Alberta Wildlife Status Report No. 64

Alberta Conservation Association

Alberta

Status of the Western Small-footed Bat (*Myotis ciliolabrum*) in Alberta

Prepared for:
Alberta Sustainable Resource Development (SRD)
Alberta Conservation Association (ACA)

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PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the general status of wildlife species in Alberta. These overviews, which have been conducted in 1991 (*The Status of Alberta Wildlife*), 1996 (*The Status of Alberta Wildlife*), 2000 (*The General Status of Alberta Wild Species 2000*), and 2005 (*The General Status of Alberta Wild Species 2005*) assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A key objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general status exercise, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are *At Risk* or *May Be At Risk* in the province, that are of uncertain status (*Undetermined*), or that are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information that will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information that will assist Alberta's Endangered Species Conservation Committee in identifying species that may be formally designated as *Endangered* or *Threatened* under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

Western small-footed bats (*Myotis ciliolabrum*) are widely distributed and locally common in western North America. They are at the northern limit of their distribution in Alberta, where they are confined to prairie river valleys where badlands or clay cutbanks provide suitable roosting habitat, and adjacent riparian woodlands provide foraging habitat. Their limited distribution has resulted in a conservation ranking of Sensitive in Alberta.

Western small-footed bats are highly saxicolous (residing in rock crevices), having greater roost specificity than other residential prairie bat species, which are more often found in buildings. In Alberta, during the reproductive period, western small-footed bats roost in cavities in badland clay banks and rock crevices, selecting maternity roosts based on thermal properties.

Winter acoustic records have demonstrated overwintering in Dinosaur Provincial Park, at the Atlas Coal Mine area near East Coulee, and in Dry Island Buffalo Jump Provincial Park. The bats presumably hibernate in deep crevices.

Gene flow is diminished across long stretches of unsuitable habitat. Genetic analyses show that there is a regional Alberta population distinct from that further south in Montana. Distinct subpopulations, with restricted gene flow, occur within and between rivers in the province. Males and females both show philopatry to their natal area and males do not disperse further than females. During the summer, individuals cluster in family units.

Loss of prairie riparian cottonwood stands, used by bats as foraging habitat, may negatively affect population numbers of this species in the province. This species' dependency on riparian trees needs further investigation. Habitat loss for this species could also occur by direct flooding caused by dams on the lower reaches of the rivers in southern Alberta.

Reproductive rates of western small-footed bats are significantly lower than for big brown and little brown bats, which are two sympatric but more widespread species. Potential population isolation, limited area of distribution, and low reproductive rate make local subpopulations vulnerable to local extirpation.

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INTRODUCTION

The western small-footed bat (*Myotis ciliolabrum*) is a member of the large and widely distributed genus *Myotis* within the bat family Vespertilionidae. Western small-footed bats occur widely in western North America (Holloway and Barclay 2001). In Alberta, the species is ranked as *Sensitive** (Alberta Sustainable Resource Development 2007) primarily because of its extremely limited distribution in portions of prairie river valleys. In Alberta, this bat is not as rare as once believed (Rand 1948, Soper 1964). Recent surveys suggest that, although it has a limited distribution, it is abundant in several locations in southern Alberta (Holloway 1998, C. Lausen, unpubl. data).

Western small-footed bats are associated with arid environments (Holloway and Barclay 2001). In Alberta, capture records are confined to southern river valleys. These areas are generally arid with high midsummer temperatures, have patchy riparian woodlands for bat foraging, and badlands or banks that provide shallow summer roosts and, in some areas, deep crevices for hibernation. Loss of riparian forests—the indirect result of lack of flooding caused by water control associated with upstream dams—may be the greatest threat to the populations.

This report compiles and summarizes recent information on the western small-footed bat as a step toward updating its current status in Alberta.

SPECIES TAXONOMY

The common and scientific names used for *Myotis ciliolabrum* have a somewhat confusing history (Foresman 2001, Holloway and Barclay 2001), but the specific identity or distinctness of the animals found in Alberta have not been in question. The following names for this species may be encountered in the literature referring to bats from this province (major publications using the names are identified):

1. Say's masked bat - *Myotis subulatus* (Rand 1948, Soper 1964);
2. Small-footed myotis (bat) - *M. leibii* (Barbour and Davis 1969, Banfield 1974);
3. Western small-footed bat - *M. ciliolabrum* (van Zyll de Jong 1985, Smith 1993).

Based on measurements and biochemical evidence, van Zyll de Jong (1984) separated the western and eastern populations of the small-footed bat (*Myotis leibii*) into two species, the western small-footed bat (*Myotis ciliolabrum*) and the eastern small-footed bat (*Myotis leibii*). Therefore, literature prior to 1983 and for a short while after, refers to *M. leibii* as occurring in Alberta.

There are two recognized subspecies of western small-footed bat: *Myotis ciliolabrum ciliolabrum* occurs over the northern portion of the Great Plains, including southern Alberta, and is pale, generally flaxen dorsally, and nearly white ventrally; *M. c. melanorhinus* is darker and more yellow dorsally, whereas the ventral side is buffy (van Zyll de Jong 1985, Holloway and Barclay 2001). This form occurs in British Columbia and the western and southwestern U.S. and Mexico.

The western small-footed bat is the smallest bat species in Alberta. In Alberta, confusion of western small-footed bats with members of the pale prairie populations of little brown (*Myotis lucifugus*) and long-legged (*Myotis volans*) bat is possible; the comparatively small foot (less than one-half the length of the tibia) is distinctive and probably the most reliable characteristic for those not familiar with the species or when identifying hand-held individuals in the light of a head lamp (T.

* See Appendix 1 for definitions of selected status designations.

Schowalter, unpubl. data). The forearm lengths of little brown and small-footed bats increase from north-central Montana through southern Alberta (Lausen et al. in prep. a), however, forearm sizes differ between these species in all locations and are thus diagnostic. Further diagnostic descriptions of Alberta bat species can be found in van Zyll de Jong (1985), Pattie and Fisher (1999) and Smith (1993).

HABITAT

Throughout its range in Alberta (Figure 1), the western small-footed bat is associated with arid or semi-arid environments with cliffs, talus slopes, or clay banks. These environments tend not to be well treed in the eastern portions of the North American distribution, but in the west the species is found in open forests (Holloway and Barclay 2001). Mesic habitats are also used in the southern part of the species' range.

In Alberta, western small-footed bats are associated with the badlands (sparsely vegetated, highly eroded areas of soft sedimentary rock) along prairie rivers (Smith 1993, Holloway and Barclay 2000, Lausen et al. in prep. b). These badlands are patchily distributed along the Red Deer, South Saskatchewan and Milk rivers. Therefore, highest concentrations of western small-footed bats occur in pockets along these rivers (C. Lausen, unpubl. data). Genetic, radio-tracking, and acoustic evidence supports the notion that individuals of this species roost close to sources of water (on average 290 m, Adams and Thibault 2006). The species is strongly saxicolous (rock-roosting), and its thermal requirements for sun-heated maternity roosts in shallow crevices and deep frost-free retreats for hibernation (Lausen and Barclay 2006, Lausen et al. in prep. b) likely limit its distribution to where those types of roosts are available along prairie river valleys.

Capture and acoustic records suggest that western small-footed bats do not wander far from rock-crevice areas of the river valleys. Holloway and Barclay (2000) found that total bat activity (including western small-footed bats) dropped off sharply with distance from the South Saskatchewan River valley. Holloway (1998) further found that areas of the lower Red Deer River valley with extensive riparian woodlands but no badlands or large cutbanks lacked western small-footed bats, whereas they were readily captured in nearby extensive badland areas along the South Saskatchewan River. It was also found that the *Myotis* species made extensive use of riparian woodlands and springs in coulees as feeding areas, which also corresponded to the locations of greatest abundance of insects (Holloway and Barclay 2000).

In the southern portion of the province, there are approximately 5500 km^2 of badlands habitat (D. Vujnovic and D. Hunter, pers. comm.); however, as only a portion of this habitat is along rivers with riparian feeding areas, the area occupied by the western small-footed bat would be much less. Although this species is most often captured in or near riparian cottonwood stands, its dependency on them as foraging habitat is not known. Acoustic studies suggest that this species' activity is three times higher in treed versus treeless stretches of river valley (Holloway and Barclay 2001); however, an investigation of foraging behaviour of western small-footed bats in prairie riparian areas is needed to evaluate the degree of dependency. Because riparian woodlands are disappearing — the indirect result of lack of flooding caused by upstream dams, together with agricultural factors preventing regeneration (Rood and Mahoney 1990, Cordes et al. 1997) — seemingly preferred habitat for this species will continue to decline. As long as dams are not constructed in the lower reaches of southern Alberta rivers, roosting habitat should remain available for this species. Some badlands features have already been flooded in Alberta by the Oldman Dam, and just across the border in Montana by the Fresno Dam. It is not known how much of an impact, if any, this had on western small-

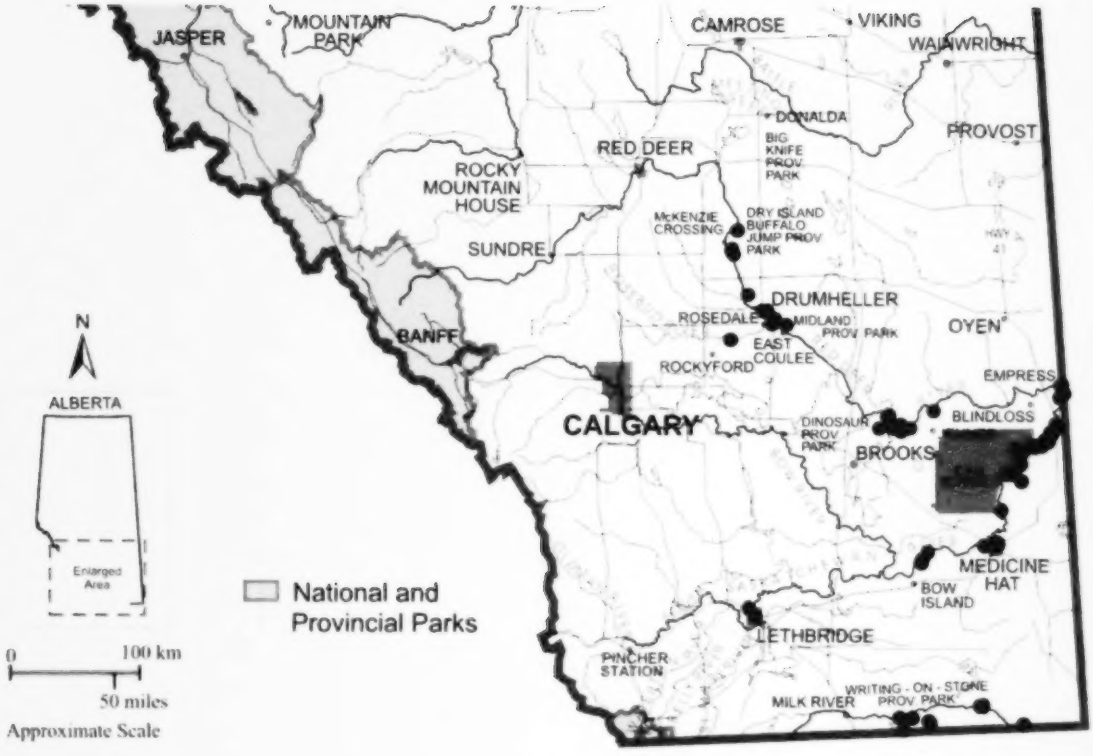

Figure 1. Geographic distribution of capture records of western small-footed bats in Alberta. Data sources: Alberta Sustainable Resource Development (2005), Jones (1974), Lausen (2006), Rand (1948), Royal Alberta Museum (2007), J. Gruver (pers. comm.) and J. Coleman (pers.comm.). Possible record in southwest foothills reported by Collister and Hunt (1990) is not shown.

footed bats given the lack of pre-dam surveys. Small sections of roosting and foraging habitat have been destroyed through bridge, road and pipeline construction, and developments associated with cities and industry (e.g., near Medicine Hat and Lethbridge).

Extensive badland formations are not the only river valley features that provide suitable roosting habitat for this species. Captures in the Empress area near the Saskatchewan border, and near Bow Island (C. Lausen, unpubl. data; Figure 1), where extensive badlands are lacking, provide evidence that clay cutbanks provide suitable habitat as well. Captures in these areas occurred near clay banks but not in areas with grassy slopes (C. Lausen, unpubl. data).

Holloway (1998) and Lausen et al. (in prep. b) examined roosts of western small-footed bats in the badlands along the South Saskatchewan River. Both found that this species roosts predominately in small "mudstone" erosion holes (68% of roosts; Lausen et al. in prep. b), which are eroded crevices in solidified mud/clay rich in bentonite (Lausen 2001 and 2007). Mudstone roosts tend to have small openings (Holloway 1998, Holloway and Barclay 2001, Lausen et al. in prep. b), are shallow, face south/southeast for good solar insolation, are generally in banks of low/gentle slope, and are on average about 1.3 m above level ground (Lausen 2007). However, western small-footed bats were also found roosting in boulder cracks and cavities created by piles of rocks on the ground (Lausen et al. in prep. b), and in large "water erosion cracks descending into the ground on relatively flat slopes" (Holloway 1998, p. 38). Roosting by the species in these latter "ground roosts" has not been described elsewhere. Mudstone provides better insulation than denser rock (Lausen and Barclay 2002), and diurnal roosting in mudstones by western small-footed bats has been widely observed (Merriam 1886, Koford and Koford 1948, Quay 1948, Barbour and Davis 1969, Tuttle and Heaney 1974, Robbins et al. 1977, Garcia et al. 1995, Holloway 1998, Navo et al. 2002). Reproductive females in South Dakota badlands use shallow south-facing mudstone erosion holes with similar properties to those described for Alberta (Tuttle and Heaney 1974). Western small-footed bats use small natural caves as night roosts in Alberta (Schowalter and Allen 1981, Holloway 1998, C. Lausen, unpubl. data) and elsewhere (Holloway and Barclay 2001). Neither Holloway (1998) nor Lausen et al. (in prep. b) tracked radio-tagged western small-footed bats to roosts in trees, despite there being large trees available in the study areas.

Holloway (1998) reported roost emergence counts of 2 to 35 individuals. The latter number, if all the bats observed were western small-footed bats, would indicate one of the largest groups observed for the species. This species has occasionally been observed roosting with other species (C. Lausen, pers. obs.), therefore emergence counts cannot always be assumed accurate. Lausen et al. (in prep. b) found reproductive females typically roosted alone or in pairs, but were found in maternity colonies as large as five individuals. In South Dakota, 10 of 12 roosts had only one bat (Tuttle and Heaney 1974).

Individuals switch roosts frequently, usually daily (Lausen 2007), but remain in a small "roost area." Home range size for western small-footed bats is not known with certainty; however, recorded movements are short. For radio-tagged bats, mean distance between successive roosts by individuals was 45 ± 6 m along the South Saskatchewan River (range 6.4 m – 106 m). The mean distance between the mist-net capture location and first roost for an individual was 146 ± 23 m (range 4 m – 580 m). Banding recapture records from the South Saskatchewan River suggest location fidelity in both sexes and all ages (Lausen 2007).

Buildings and other artificial structures are probably of trivial importance to western small-footed bat populations, given that only rarely have individuals been reported from human-made structures (Stephens 1945, Dalquest 1948, Koford and Koford 1948, Davis and Cockrum 1963, Jones 1964, Barbour and Davis 1969, Swenson and Shanks 1979, Hendricks et al. 2005); in Alberta, there is only one record of a western small-footed individual in a building (Schowalter and Allen 1981).

CONSERVATION BIOLOGY

1. Flight Behaviour. - Western small-footed bats are erratic, slow flyers (Dalquest 1948, Schowalter and Allen 1981) and do not move far seasonally or during their lifetime (Lausen 2007). These bats are most frequently captured along low cliff faces, near bushes and trees (Fenton et al. 1980, C. Lausen, unpubl. data), or over small bodies of water (Hardy 1941, Kuenzi et al. 1999). Woodsworth (1981) observed that individuals tend to follow a repeating path while foraging. Western small-footed bats are early flyers, emerging soon after sunset (Fenton et al. 1980) and often concentrating their early foraging activity around vegetation along the edges of rock faces (Fenton et al. 1980, C. Lausen, unpubl. data). Capture efforts by Lausen (2007) suggest that female western small-footed bats may use night roosts more than other species as they are captured less often in the middle of the night, compared to other prairie species. Studies of physiological and foraging patterns are needed to understand why this might occur.

2. Population Genetics. - The patchiness of suitable roosting habitat along prairie rivers has produced a patchy distribution of this species (C. Lausen, unpubl. data). Lausen (2007) studied the degree of connectivity among patches of individuals in a genetic analysis of western small-footed bats from locations along the Red Deer, South Saskatchewan, Milk and Missouri rivers. The research determined that gene flow is limited by distance and by topography. Gene flow occurred along most rivers between sites that were close (less than 150 km) with suitable habitat between sites; the one exception to this was on the South Saskatchewan River where the Bow Island subpopulation showed limited gene flow with the subpopulation near C.F.B Suffield. One western small-footed bat was captured in Medicine Hat (S. Holroyd, pers. comm.) and one just outside the city (C. Lausen, unpubl. data), but in general, this species seems uncommon in the Medicine Hat region, despite suitable mudstone habitat.

Between-river gene flow is limited in this species, and hierarchical genetic analysis revealed that western small-footed population structure reflects river topography. Neither males nor females move far to mate, and males, like females, are philopatric to their natal area to a larger extent than other prairie bat species (Lausen 2007). Males and females generally stay within a river and river system to mate and hibernate, but then return to their natal areas in the summer where males, as evidenced by their mitochondrial DNA (mtDNA), roost close to their female relatives. Closely related females roost together (all roost-mates are of a single matriline), or within metres of each other, producing small clusters of related males and females along the rivers (Lausen 2007). Each site sampled by Lausen (2007) had at least one unique mitochondrial DNA haplotype, suggesting the loss of bats in one stretch of the river would cause the loss of a set of unique genes from the population.

Breeding seems to preferentially occur between clusters of individuals that are in close proximity along a river valley (less than 150 km, Lausen 2007). Genetic results suggest that although gene flow is primarily within rivers and river systems, genetic exchange also occurs along appropriate habitat corridors (e.g., stream banks or long coulees) that exist between rivers (Lausen 2007). Western small-footed bats are more genetically structured than little brown

and big brown bats in the prairies, likely due in part to small size (relatively poor flight ability) and roost specificity (Lausen 2007).

Dispersal is the moving of individuals away from their place of birth (Ricklefs 1990). Average dispersal distance is low in this species (male dispersal distance 70 km – 134 km; Lausen 2007), in contrast to other bat species in the prairies (big brown bats 460 km, little brown bats 600 km; Lausen 2007). Mammals tend to have male-biased dispersal (Greenwood 1980), but that is not the case for western small-footed bats (Lausen 2007). Where mating takes place is not known, but as more prairie hibernation areas are found for this species, a better understanding of gene flow may ensue.

Mitochondrial DNA analyses show that there is limited and perhaps no dispersal of female or male western small-footed bats between Alberta and the Missouri River of Montana. Nuclear gene flow supports limited mating between Missouri and Alberta individuals, suggesting that some barrier may exist to hinder movement of individuals between the Milk and Missouri rivers. Lausen (2007) points to a long (500-km) stretch of river valley between the Milk and Missouri rivers where no suitable western small-footed bat roosting habitat exists. Interestingly, Lausen's sampling sites on the Milk and Missouri rivers are only approximately 60 km apart, reinforcing the finding that western small-footed bats tend to be restricted to staying within river valleys, and that stretches of unsuitable roosting habitat can impact connectivity between groups of individuals.

3. Winter Behaviour. - Western small-footed bats have been detected in winter in Dinosaur Provincial Park, at the Atlas Coal Mine area near East Coulee (Lausen and Barclay 2006), and in Dry Island Buffalo Jump Provincial Park (Lausen 2006), providing evidence that the animals hibernate locally. Travel between summer and winter roosting areas is likely less than 200 km, based on genetic results (Lausen 2007). Presumably western small-footed bats hibernate in deep crevices in riparian badlands as do big brown bats (*Eptesicus fuscus*, Lausen and Barclay 2006). Western small-footed bats have been observed widely, although in small numbers, to hibernate in caves and mines throughout most of its distribution (Holloway and Barclay 2001). Abandoned mines might be used as hibernacula in the East Coulee region.

Bats arouse periodically during hibernation and may venture out of their roosts in search of water (Lausen and Barclay 2006). Periodic arousal uses energy reserves and because these reserves are limited by lack of insect food during winter, it is not known how many arousals individuals can and do make throughout the winter.

4. Reproduction. - The life-cycle of western small-footed bats appears to be similar to those of many other *Myotis* species in North America. Mating takes place in the fall or winter, before or during hibernation. Reproductive rates of western small-footed bats are low. Generally, a single offspring is born in June or July (Barbour and Davis 1969, Holloway and Barclay 2001); only single young have been observed in Alberta (C. Lausen, unpubl. data). One exception was an occurrence of twins inferred from an observation of two young with a single female in South Dakota (Tuttle and Heaney 1974). Although relatively few bats have been banded in areas where sampling occurred over several years, recapture of several female western small-footed bats on the South Saskatchewan River demonstrated that adult females do not reproduce each year (C. Lausen, unpubl. data). In southern Alberta, after the onset of lactation, the overall ratio of reproductive to non-reproductive adult female western small-footed bats was 197:154 (56.1% reproductive, 2001 – 2005; Lausen 2007). This is significantly lower than the reproductive rates of 78.3% (227/290) and 74.9% (311/415) for big brown and little brown bats, respectively, also from southern Alberta in 2001-2005

(Lausen 2007). Kuenzi et al. (1999) found only 41.2% of 51 adult female western small-footed bats in Nevada to be reproductive, suggesting that a low reproductive rate is typical for this species. Although longevity is not known for this species, bats tend to be long-lived, and record ages for other species found in southern Alberta range from 19 – 34 years (Wilkinson and South 2002); long lifespan presumably offsets their low reproductive rates (Barclay et al. 2004).

Outside of Alberta, sex ratios of captured adult western small-footed bats have favoured males (Bogan et al. 1996; Cryan et al. 2000; Hendricks et al. 2004; Hendricks and Maxell 2005). In Montana, just across the Alberta border on the Milk River near Havre, the ratio of males: females was 59:2, despite great effort to find females (C. Lausen, unpubl. data). In contrast, in Alberta, Lausen (unpubl. data) found that the sex ratios are closer to 50:50, with males (406) captured slightly less than females (457). The extreme sex bias in some prairie capture locations (Montana, South Dakota) is not understood. Sex ratios may reflect differences in thermal or food resources, making some areas better suited to one sex over the other (Cryan et al. 2000, Grindal et al.1999).

DISTRIBUTION

1. Alberta. - In Alberta, the western small-footed bat is known from the prairie river valleys and associated coulees of the South Saskatchewan, Red Deer and Milk river basins (Figure 1). Captures have primarily been made in four regions in Alberta: Dry Island Buffalo Jump Provincial Park south to East Coulee on the Red Deer River (Alberta Sustainable Resource Development 2005, Lausen 2006, Lausen and Barclay 2006; J. Gruver, pers. comm.); Dinosaur Provincial Park from Steveville through to the Jenner Crossing (Jones 1974, Schowalter and Allen 1981, Alberta Sustainable Resource Development 2005, C. Lausen, unpubl. data) in the Red Deer River; from the Saskatchewan border near Empress to approximately half the distance to Medicine Hat along the South Saskatchewan river valley (Holloway 1998, C. Lausen, unpubl. data, Alberta Sustainable Resource Development 2005); from the eastern crossing of the international border on the Milk River, upriver (west) to Writing-on-Stone Provincial Park (Soper 1964, Smith 1993, Alberta Sustainable Resource Development 2005, M. Saunders, pers. comm., C. Lausen, unpubl. data). Some western small-footed bats have also been captured on the South Saskatchewan River north of Bow Island. Here it took several months of nightly mist-netting to capture the same number of western small-footed bats as could be captured in a single night of sampling downriver near the Saskatchewan border (C. Lausen, pers. comm.). In 2007, a single western small-footed bat was captured near Rockyford on the Rosebud River, a tributary of the Red Deer River (J. Coleman, pers. comm.).

What appears to be suitable badlands habitat occurs in the Red Deer River valley north of Dry Island Buffalo Jump, along the Battle River in Big Knife Provincial Park and upriver along Meeting Creek near Donalda. However, surveys in those locations resulted in no captures or auditory detection of western small-footed bats, though the portions of the Red Deer River valley north of Dry Island Buffalo Jump Provincial Park should be surveyed further (Lausen 2006). Capture effort and acoustic monitoring along Meeting Creek were sufficient to suggest that western small-footed bats are rare or absent there (Appendix 2).

Many areas of southern Alberta have not been surveyed for this species. For example, well-developed badlands habitat and riparian woodlands continue further downstream of East Coulee on the Red Deer River, but it has not been surveyed for bats. Suitable western small-footed bat habitat exists along stretches of the Belly, Old Man, Waterton and St. Mary rivers (C. Lausen, pers. obs.), suggesting

this bat may be found south and west of Lethbridge. However, with the exception of a small stretch of the Old Man River north of Pincher Station (just northwest of the town of Pincher Creek), rivers south and west of Lethbridge have not been surveyed; despite the presence of cutbanks in the area near the Old Man Reservoir, substantial netting efforts in 2006 and 2007 found no western small-footed bats (more than 200 bats captured in total, Appendix 2; E. Baerwald pers. comm.). There are several specimens of western small-footed bats recorded as being from near Lethbridge (Figure 1) in the collections of the Royal Alberta Museum in Edmonton (Royal Alberta Museum 2007; D. Gummer pers. comm.), but some of these specimens may have been submitted for rabies testing to the Animal Diseases Research Institute near that city (T. Schowalter, pers. obs.), making their location of origin uncertain. There is a single report of a western small-footed bat from the southwestern foothills (Collister and Hunt 1990); unfortunately, that record was not accompanied by photographs or measurements, and it did not appear that the authors were aware that little brown bats in southern Alberta are very pale coloured, similar to western small-footed bats (Smith and Schowalter 1979, Lausen 2006). Few surveys have been conducted on the Bow River; in 2006 and 2007, mist-netting along the Bow River south and east of Calgary produced no captures of western small-footed bats (J. Coleman, pers. comm.).

The extent of occurrence for this species can be roughly estimated as 50 188 km^2 using a convex hull polygon; however, this estimate contains areas outside of the river valleys where this species has not been found, and would be considerably smaller if those areas were removed. The total area that western small-footed bats occupy in Alberta is unknown. Although it is assumed that the species is essentially confined to prairie river valleys, little capture effort has taken place outside of the badlands areas. A rough estimate of the area of occupancy ranges from 276 km^2 (overlaying a 2-km by 2-km grid on existing locations and multiplying the number of occupied grid cells by the area of each cell) to 1250 km^2 (if considered as several strips along prairie river valleys). The latter number assumes that the "distribution" is 3 km wide – an approximation of valley and foraging area width – along 80 km of the upriver part of the lower Red Deer River, 95 km along the Milk River and 170 km of the South Saskatchewan River. A width of 5 km was assumed for an additional 43 km in the downriver part of the lower Red Deer River around Dinosaur Provincial Park. Most of these areas consist of well-developed badlands terrain; however, approximately 112 km (336 km^2) along the South Saskatchewan River from about half way between the Saskatchewan border and Medicine Hat upstream to Bow Island consists of fragmented habitat with varying gaps between outcrops and large cutbanks. In addition, some small stretches of the Milk River valley included here may not have suitable habitat for western small-footed bats.

It is likely that the overall species distribution does not differ substantially between summer and winter, although during winter months western small-footed bats are likely clustered in fewer areas along the rivers, where pockets of deep crevices allow hibernation.

2. Other Areas. - The western small-footed bat is widely distributed in western North America (Holloway and Barclay 2001) ranging from British Columbia, Alberta, and Saskatchewan, to south-central Mexico (Figure 2). The species does not occur along the Pacific coast of Washington, Oregon, and most of California. Where it does occur, it ranges from 300 m to 3300 m in altitude (Nagorsen and Brigham 1993).

Western small-footed bats occur in jurisdictions neighbouring Alberta, including Saskatchewan, British Columbia, and Montana. The only

Figure 2: Geographic distribution of western small-footed bats in North America (adapted from Holloway and Barclay 2001 with modifications from Foresman [2001] and data compiled from this review). 1. *M. c. ciliolabrum*; 2. *M. c. melanorhinus*.

two published records from Saskatchewan are from the west-central portion of the South Saskatchewan River drainage (Beck 1958; Nero 1958, 1959). Suitable eroded banks and badlands terrain occur widely along the South Saskatchewan River in Saskatchewan and are likely to support western small-footed bats (C. Lausen, pers. obs.). In British Columbia, the species has long been recognized from the Okanagan and Similkameen valleys and is known further north from the Chilcotin River and Williams Lake (Nagorsen and Brigham 1993). Western small-footed bats occur widely in Montana (Foresman 2001, Hendricks and Maxell 2005). Winter records of hibernating western small-footed bats in neighbouring jurisdictions include a few individuals in a coal mine in south-central Montana (Swenson 1970) and in caves and mine adits (entrances) in the Okanagan and Williams Lake regions of British Columbia (Nagorsen and Brigham 1993).

POPULATION SIZE AND TRENDS

1. Alberta. - There are insufficient data for estimating population size or evaluating long-term trends of Alberta populations of western small-footed bats. Until the 1970s, there were only two records of the species from Alberta (Rand 1948, Soper 1964). Soper's (1964) assessment of the species as "rare" likely stemmed from limitations of collecting activities. Changes in sampling methodologies over time have made it difficult to compare current with historic abundance for many bat species (Pierson 1998). With the advent of mist-netting, enough captures were made in the 1970s near Jenner (Jones 1974), west of Rumsey (T. Schowalter, pers. obs.), and Dinosaur Provincial Park (Schowalter and Allen 1981) to suggest that the species was relatively abundant in relation to other bat species in those areas. As well, there were a number of submissions of rabies-suspect specimens from locations in the south of the province (T. Schowalter, pers. obs.).

Research that has focused on prairie bats, based in the R. Barclay lab at the University of Calgary, has demonstrated that western small-footed bats are common in certain areas in prairie river valleys. Along badlands areas of the South Saskatchewan River, Holloway (1998) found the western small-footed bat to be the most frequently captured species at rates of 0.37, 0.21 and 0.16 bats/mist-net-hour at sites along treed river stretches, in coulees and at springs, respectively. Unfortunately, comparable capture rate data are not available for other areas for that period. Similarly, capture rates in this area at later dates are not comparable given that general mist-netting was not conducted again; rather, certain bat species were targeted for various research projects.

The proportion of western small-footed bats captured in Alberta from 2001 to 2006 relative to total bat captures provides a general idea of the relative abundance of the species in different regions (Appendix 2; C. Lausen, unpubl. data). However, because certain species were being targeted for different studies during most of these capture sessions (e.g., strategic net placement and net heights to match species of interest), only estimates of relative abundance can be made. Western small-footed bats seem to be most abundant in Dinosaur Provincial Park and along the lower reaches of the South Saskatchewan and Milk rivers. It is least abundant on the edges of its known distribution: in the north, upriver of Drumheller on the Red Deer River, and in the south in the Writing-on-Stone Provincial Park region of the Milk River (Appendix 2).

The life histories of bats (i.e., low reproductive rates, high overwinter juvenile mortality; Barclay et al. 2004) make their populations vulnerable to declines, and therefore being able to monitor trends in populations of bats is highly desirable (O'Shea and Bogan 2003a). Bats in North America tend to roost concealed and are therefore cryptic, making them difficult to census. When bats aggregate in moderate

numbers, emergence counts and roost counts can provide rough estimates of local population numbers (Kunz 2003). Species that roost in small groups or alone in crevices (over-dispersed bats) pose the greatest challenge for censusing (Kunz 2003) – western small-footed bats fall into this category. The lack of standard protocols to collect comparable data over time limits estimation of bat populations across the continent (O'Shea and Bogan 2003b). There are many challenges to estimating bat populations and monitoring trends, and much hope relies on improved future technology, such as better mark-resight techniques that do not require recapture (O'Shea and Bogan 2003b). Based on surveys by Lausen (unpubl. data, 2007) and others it is clear that there are at least four areas in the province where this species is relatively abundant (clusters described above). Mark-recapture efforts in these areas may provide an estimate of abundance, but currently no such numbers are available.

2. Other Areas. - Western small-footed bats are common in badlands, semi-arid and desert areas in western North America (Holloway and Barclay 2001). Nowhere are there sufficient data to support evaluation of trends in numbers. They have been noted to be the most frequently captured bat species in Badlands National Park, South Dakota (Farney and Jones 1980, Bogan et al. 1996), in west-central Nevada (Kuenzi et al. 1999), and in the desert of eastern Washington (Dalquest 1948). In Montana, the species has been thought to be uncommon but widely distributed (Foresman 2001, Hendricks and Maxell 2005). As in Alberta, western small-footed bats are locally abundant in badlands regions of prairie rivers in Montana (C. Lausen, unpubl. data); however, the species is also found in treed areas in the western part of the state (Hendricks and Maxell 2005). Moderate numbers are known from the more arid regions of southern British Columbia (Nagorsen and Brigham 1993). There are too few records to establish abundance in Saskatchewan (Nero 1958, 1959; Beck 1958, C. Lausen, unpubl. data).

LIMITING FACTORS

In Alberta, western small-footed bats appear to be confined to crevice-rich areas in prairie river valleys. Summer clusters are patchy and genetic analyses suggest there are several local populations separated by regions of poor habitat. Dispersal distances and reproductive rates are low, suggesting a subpopulation of this species is unlikely to rebound from a catastrophic event. Any threat to rock-roosting habitat within river valleys threatens this species; destruction of large areas of roosting habitat (such as flooding from dams) has the potential to not only isolate populations but to reduce the likelihood of a population being re-established by immigration should one be lost. The proposed Meridian dam would have flooded a large section of the South Saskatchewan River, including one of the four major areas of western small-footed bat habitat in the province. However, this dam was deemed unfeasible (Government of Alberta 2002).

Other than direct flooding from potential construction of dams downstream, there appear to be few developments potentially affecting most of the river-valley badlands terrain in southern Alberta. Holloway and Barclay (2000) considered that although the overall roosting habitat (essentially badlands in prairie river valleys) of western small-footed bats is relatively secure, essential foraging habitat around riparian trees and springs is less secure. Construction of dams upstream and consequent reduced frequency and severity of natural flooding events can limit or prevent recruitment of cottonwoods (*Populus* sp.) resulting in the loss of riparian woodlands along prairie rivers. It is unlikely that riparian woodlands along the lower Red Deer River, for example, will regenerate, as a result of the Dickson Dam upriver of Red Deer (Cordes et al. 1997). Riparian areas might also be

affected by overgrazing or conversion of river valley "flats" to irrigation cropland (Rood and Mahoney 1990). The importance of riparian woodlands to prairie bats has been widely recognized (Brigham 1993, Holloway and Barclay 2000). The loss of riparian woodlands is likely to negatively impact this species.

It is not clear what impact climate change will have on prairie bats. If the Canadian prairie climate continues to become drier with climate change, as predicted by Environment Canada (1997), bats hibernating in rock crevices may be burdened with additional evaporative water loss brought about by decreased humidity and increased temperatures (Kallen 1964). Because periodic winter flight of bats has been associated with dry climates (e.g., high altitude Nevada and New Mexico, southern Alberta prairies; summarized in Lausen and Barclay 2006), one response may be more frequent arousal and winter flights, placing greater strain on stored fat reserves; however, shorter winter seasons may occur, resulting in a shorter hibernation period thus balancing the changes that may occur in energy budgets. Alternatively, bats may be forced to seek other hibernation areas. In the Canadian prairies, where higher altitude refugia are not available, distributional ranges for bats may shift (Humphries et al. 2002). This shift may necessitate greater flight distances between summer and winter areas, and movement out of river valleys and through areas of unsuitable habitat patches, which may not be possible for western small-footed bats owing to their small size and poorer flight ability than other Alberta bat species. Predicted increase in prairie drought (Environment Canada 1997) will certainly put additional pressure on governments to dam and divert rivers (Schindler and Donahue 2006), and if damming occurred in the range of western small-footed bats, the associated habitat loss would likely have negative consequences for this species, as outlined above.

Wind energy development is on the increase in Canada (CanWEA 2008), and wind turbines cause bat fatalities (Arnett et al. 2008). While most wind-turbine bat fatalities across North America are the high-flying migratory species, other species (e.g., *Myotis*) have been reported to make up more than 20% of fatalities at several wind farms, including one site in southwestern Alberta (Arnett et al. 2008). To date, no turbines in Alberta have been built near riparian areas with known populations of western small-footed bats; however, one wind farm located adjacent to Castle River (west of Pincher Creek) reported 23% of its fatalities to be little brown bats (Arnett et al. 2008). These *Myotis* fatalities suggest that wind developments might impact western small-footed bats if turbines were to be built near one of their main subpopulations. Prior to such a development, study of foraging western small-footed bats would be advisable to determine whether they forage at heights or distances from river valleys that would put them at risk.

STATUS DESIGNATIONS*

1. Alberta. - In 2005, the western small-footed bat was ranked as *Sensitive* because of the apparently clumped and disjunct distribution and lack of knowledge about the populations (Alberta Sustainable Resource Development 2007). It has had the equivalent general status rank since 1996 (Alberta Wildlife Management Division 1996, Alberta Sustainable Resource Development 2001).

The Alberta Natural Heritage Information Network (2007a) ranks western small-footed bats as S2 in Alberta indicating that there are "6-20 occurrences" and that they "may be vulnerable to extirpation." Here the term occurrences refers to "main pockets of abundance," or discreet areas where this species is consistently found (W. Nordstrom, pers. comm.). These occurrences seem to refer to genetic subpopulations.

* See Appendix 1 for definitions of selected status designations.

In Alberta, all bats are identified as "non-licence animals" under the Alberta *Wildlife Act* and *Wildlife Regulations*. This designation means that bats can be hunted or harvested without a permit. However, hibernacula of all bats in Alberta are protected from disturbance between 1 September and 30 April and, for reasons of public health safety, a person may not be in possession of a live bat other than to temporarily capture and relocate it from one's property (Government of Alberta 2005).

2. Other Areas. - In British Columbia, western small-footed bats are ranked as "S2S3 Blue List." S2 identifies the species as "Imperiled" whereas S3 identifies it as being of "Special Concern." Blue-listed species are taxa that are at risk but not Extirpated, Endangered or Threatened (British Columbia Conservation Data Centre 2007). Saskatchewan ranks the species as S3B, SNRN (Saskatchewan Conservation Data Centre 2007), which indicates that the species may be at risk, but that the lack of knowledge of the animal in that province makes certain ranking impractical. The general status of the western small-footed bat is *May Be at Risk* in B.C. and *Sensitive* in Saskatchewan (CESCC 2006).

Globally, western small-footed bats are ranked G5 (NatureServe 2007) as there are probably over 100 occurrences and the species is demonstrably secure. It is not ranked in Montana (Montana Natural Heritage Program 2007) or Idaho (Idaho Fish and Game 2006), or the United States generally (United States Fish and Wildlife Service 2007).

RECENT MANAGEMENT IN ALBERTA

Although there has been no specific management of western small-footed bats in Alberta, there has been considerable research by Holloway (1998) and currently by Lausen, as described in this report. As a result, the knowledge available for management of the species in the province is greater than that available elsewhere.

Population size estimation and data upon which to evaluate population trends are lacking, but the stage has been set for these data to be collected; a large number of western small-footed bats has been banded in several regions of Alberta (approximately 700 individuals from 2002 to 2005; C. Lausen, unpubl. data), and therefore the opportunity exists to monitor in these areas. Such monitoring would have to begin soon to make best use of these marked individuals, given that the time between marking and re-sighting sessions needs to be minimized to produce best results for population estimation (O'Shea and Bogan 2003b).

Landscape-level habitat modeling done for western small-footed bats in the MULTISAR project (Quinlan et al. 2004, Landry 2004) required that basic spatial and temporal habitat selection and behaviour be known for western small-footed bats. Although basic information was gleaned from the literature and from preliminary results of C. Lausen's work at that time, habitat modeling should be revisited for this species once its dependency on riparian cottonwoods has been investigated.

SYNTHESIS

It is reasonable to assume that the paucity of early records of small-footed bats in Alberta was a consequence of the limits of the technology and effort rather than actual scarcity of the bats. Relative to little and big brown bats in southern Alberta, western small-footed bats have low reproductive rates and short dispersal distances. Gene flow among individuals is reduced at distances of greater than 150 km and stretches of unsuitable roosting habitat. Genetic relatedness indicates that this species is structured according to river valleys, suggesting it does not tend to venture far outside of them. Subpopulations of this species seem to occur disjunctly along rivers, corresponding to patches of suitable habitat. Both males and females return to their natal areas for the summer months, roosting in neighbourhoods

of related individuals. Females generally select roosts that are in mudstone, are lower to the ground and are shallower than roosts of sympatric bat species. Still to be determined is whether this roost selection makes this species more vulnerable to disturbance/predation in areas where human populations are large.

There has been considerable research conducted on western small-footed bats in Alberta, so we now have information upon which to evaluate the conservation status of the species in Alberta. However, there are still important information gaps to fill. One area for further study is to determine if these animals occur upstream of the currently recognized distribution. Also, their abundance needs to be formally evaluated, as research efforts to date have not focused on population estimation and consequently have not used appropriate study designs for such estimation. Appropriate standardized protocols that can be used repeatedly over time to establish trends in relative abundances of all bats in prairie river valleys are needed. In general, what is required is consistent and intense effort in several areas of the prairies to census and monitor trends using mark-recapture techniques (e.g., bands or PIT-tags; O'Shea and Bogan 2003b).

As riparian cottonwoods continue to disappear (Bradley and Smith 1986), wind-turbine developments that kill bats (Arnett et al. 2008, Barclay et al. 2007) increase in numbers on the Alberta prairies (AESO 2008), and drought puts additional pressure on governments to dam and divert rivers (Schindler and Donahue 2006), the prairie landscape is almost certain to change in a way that will influence bats. It is not clear how these potential threats may affect western small-footed bat populations in Alberta. Further investigations are needed to determine the value of riparian prairie river woodlands to western small-footed bats, the causes of bat fatalities by wind turbines, and the full distribution of western small-footed bats along southern Alberta rivers.

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Appendix 1: Definitions of status ranks and legal designations.

A. The General Status of Alberta Wild Species 2005 (after Alberta Sustainable Resource Development 2007)

2005 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be *At Risk* after formal detailed status assessment and designation as *Endangered* or *Threatened* in Alberta.
May Be At Risk	Blue	Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
Sensitive	Yellow	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Secure	Green	Any species that is not *At Risk*, *May Be At Risk* or *Sensitive*.
Undetermined	Status Undetermined	Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.
Not Assessed	n/a	Any species that has not been examined during this exercise.
Exotic/Alien	n/a	Any species that has been introduced as a result of human activities.
Extirpated/Extinct	n/a	Any species no longer thought to be present in Alberta (Extirpated) or no longer believed to be present anywhere in the world (Extinct).
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.

B. Alberta Species at Risk Formal Status Designations
Species designated as *Endangered* under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation (in bold).

Endangered	**A species facing imminent extirpation or extinction.**
Threatened	**A species likely to become endangered if limiting factors are not reversed.**
Species of Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Data Deficient	A species for which there is insufficient scientific information to support status designation.

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2006)

Extinct	A species that no longer exists.
Extirpated	A species that no longer exists in the wild in Canada, but occurs elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if limiting factors are not reversed.
Special Concern	A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Not at Risk	A species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient	A category that applies when the available information is insufficient to (a) resolve a wildlife species' eligibility for assessment, or (b) permit an assessment of the wildlife species' risk of extinction.

D. Heritage Status Ranks: Global (G), National (N), Sub-national (S) (after Alberta Natural Heritage Information Centre 2007b, NatureServe 2007)

G1/N1/S1	5 or fewer occurrences or only a few remaining individuals. May be especially vulnerable to extirpation because of some factor of its biology.
G2/N2/S2	6 to 20 or fewer occurrences or with many individuals in fewer locations. May be especially vulnerable to extirpation because of some factor of its biology.
G3/N3/S3	21 to 100 occurrences; may be rare and local throughout its range, or in a restricted range (may be abundant in some locations). May be susceptible to extirpation because of large-scale disturbances.
G4/N4/S4	Typically > 100 occurrences. Apparently secure.
G5/N5/S5	Typically > 100 occurrences. Demonstrably secure.
GX/NX/SX	Believed to be extinct or extirpated; historical records only.
GH/NH/SH	Historically known; may be relocated in the future.
G?/N?/S?	Not yet ranked, or rank tentatively assigned.

E. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species that is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Appendix 2: Percentage of total bat captures (Total Caps) that were western small-footed bats (WSF) are listed for each year. All locations are in southern Alberta, contain some degree of suitable roosting habitat for western small-footed bats, and are listed generally from north to south and west to east (see Figure 1 for locations). Unless otherwise indicated, captures are by C. Lausen and were made during general mist-netting sessions (see Notes).

RIVER	LOCATION	YEAR	PERCENT WSF (%)	TOTAL CAPS.	NOTES
Battle River	Big Knife Provincial Park	2005	0	37	
	Donalda (on Meeting Creek)	2005	0	4	Western small-footed bats were targeted.
		2006	0	22	Western small-footed bats were targeted.
Red Deer	McKenzie Crossing Recreation Area	2005	0	11	
	Dry Island Buffalo Jump Provincial Park	2002	0	3	
		2005	25	32	
	Drumheller - Rosedale area	2002	20	5	
		2004	28	179	
	Dinosaur Provincial Park	2001	32	37	
		2002	74	133	
		2003	62	29	
		2004	35	534	
Red Deer/South Saskatchewan Confluence	Near Empress	2001	20	5	
		2004	3	37	Happened to net near little brown bat night roost.
South Saskatchewan	Highway 41 Crossing	2001	61	93	
		2002	80	10	
	Pipeline and Ferry Crossings	2001	47	318	
	(<20 km north of C.F.B. Suffield)	2002	54	246	Western small-footed bats were targeted.
		2004	40	107	
	Across river from C.F.B. Suffield	2001	75	8	
		2002	77	26	
		2003	14	7	Big brown bats were targeted.
		2004	49	37	
	Bow Island	2002	50	12	Western small-footed bats were targeted.
		2003	34	96	Western small-footed bats were targeted.

Appendix 2 cont.

Old Man River	Along the river north of Pincher Station	2006	0	141	Data from a general river valley survey by Erin Baerwald.
		2007	0	~70	This was from a general river valley survey by Erin Baerwald (pers. comm.).
Milk River	Writing on Stone Provincial Park and immediate area	1987	8	278	Matt Saunders' data - targeted western long-eared bats in and around park (pers.comm.)
		1988	6	291	Matt Saunders' data - targeted western long-eared bats in and around park (pers. comm.).
		2001	0	37	Netted in vicinity of little brown maternity roost.
		2002	0	12	Netted in vicinity of little brown maternity roost
		2003	3	90	General netting within park boundaries.
	Pinhorn Grazing Reserve	2002	61	85	
		2003	42	45	
		2004	42	60	

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